

The Aerosol-Monsoon Climate System of Asia

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In Asian monsoon countries such as China and India, human health and safety problems caused by air-pollution are worsening due to the increased loading of atmospheric pollutants stemming from rising energy demand associated with the rapid pace of industrialization and modernization. Meanwhile, uneven distribution of monsoon rain associated with flash flood or prolonged drought, has caused major loss of human lives, and damages in crop and properties with devastating societal impacts on Asian countries. Historically, air-pollution and monsoon research are treated as separate problems. However a growing number of recent studies have suggested that the two problems may be intrinsically intertwined and need to be studied jointly. Because of complexity of the dynamics of the monsoon systems, aerosol impacts on monsoons and vice versa must be studied and understood in the context of aerosol forcing in relationship to changes in fundamental driving forces of the monsoon climate system (e.g. sea surface temperature, land-sea contrast etc.) on time scales from intraseasonal variability (~weeks) to climate change (~ multi-decades). Indeed, because of the large contributions of aerosols to the global and regional energy balance of the atmosphere and earth surface, and possible effects of the microphysics of clouds and precipitation, a better understanding of the response to climate change in Asian monsoon regions requires that aerosols be considered as an integral component of a fully coupled aerosol-monsoon system on all time scales.

In this paper, using observations and results from climate modeling, we will discuss the coherent variability of the coupled aerosol-monsoon climate system in South Asia and East Asia, including aerosol distribution and types, with respect to rainfall, moisture, winds, land-sea thermal contrast, heat sources and sink distributions in the atmosphere in seasonal, interannual to climate change time scales. We will show examples of how elevated absorbing aerosols (dust and black carbon) may interact with monsoon dynamics to produce feedback effects on the atmospheric water cycle, leading to in accelerated melting of snowpacks over the Himalayas and Tibetan Plateau, and subsequent changes in evolution of the pre-monsoon and peak monsoon rainfall, moisture and wind distributions in South Asia and East Asia.